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*MICRO ANALOG SYSTEMS*

DA1016B.000
13 May, 2002

# MAS1016B

## AM Receiver IC

- **High Sensitivity**
- **Very Low Power Consumption**
- **Wide Supply Voltage Range**
- **Power Down Control**
- **Control for AGC On**
- **High Selectivity by Crystal Filter**

## DESCRIPTION

The MAS1016B AM Receiver chip is a highly sensitive, simple to use AM receiver specially intended to receive time signals in the frequency range from 40 kHz to 100 kHz. Only a few external components are required for time signal receiver. The circuit has preamplifier, wide range automatic gain control, demodulator and output comparator built in. The output signal can be processed directly by an additional digital circuitry to extract the data from the received signal. The control for AGC (automatic gain control) can be used to switch AGC on or off if necessary. WWVB in USA and JJY in Japan require use of AGC control procedure, which is simplified in MAS1016B.

## FEATURES

- Highly Sensitive AM Receiver, 0.5 $\mu V_{RMS}$ typ.
- Wide Supply Voltage Range from 1.1 V to 3.6 V
- Very Low Power Consumption 50 $\mu A$ typ.
- Power Down Control
- Only a Few External Components Necessary
- Control for AGC On
- Wide Frequency Range from 40 kHz to 100 kHz
- High Selectivity by Quartz Crystal Filter
- Die and TSSOP-16 Package

## APPLICATIONS

- Time Signal Receiver Designed for MSF (UK), WWVB (USA), JJY (Japan) and DCF77 (Germany)
- Receiver for ASK Modulated Data Signals

## BLOCK DIAGRAM

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## PAD LAYOUT

**1788 µm**
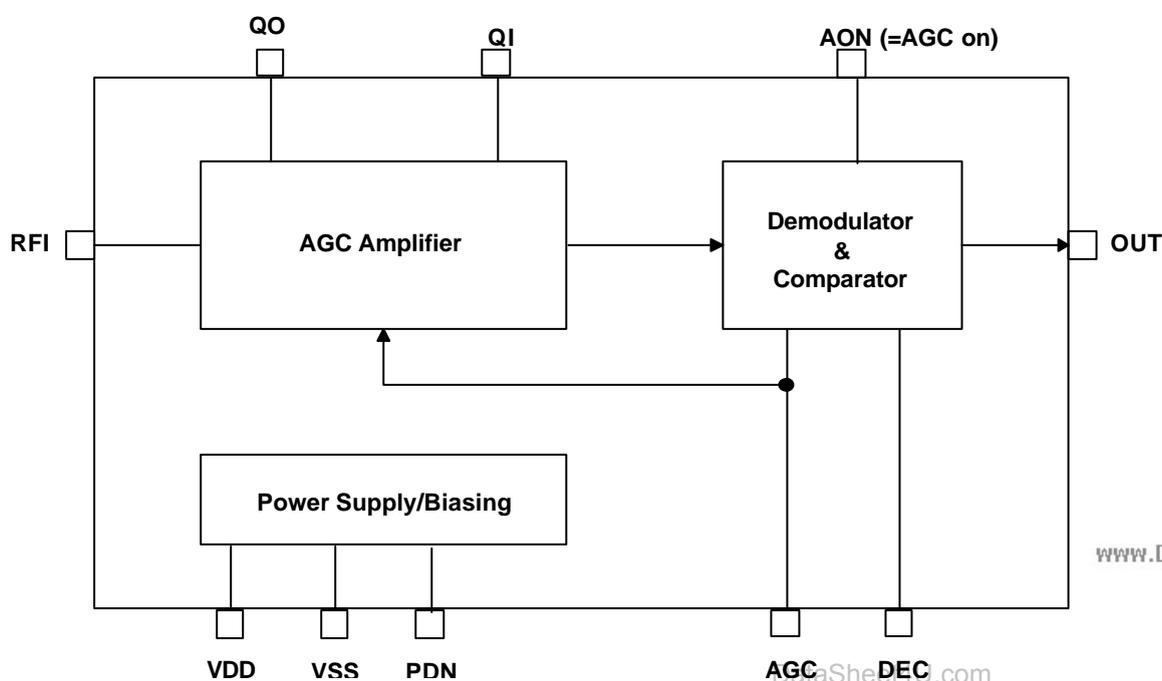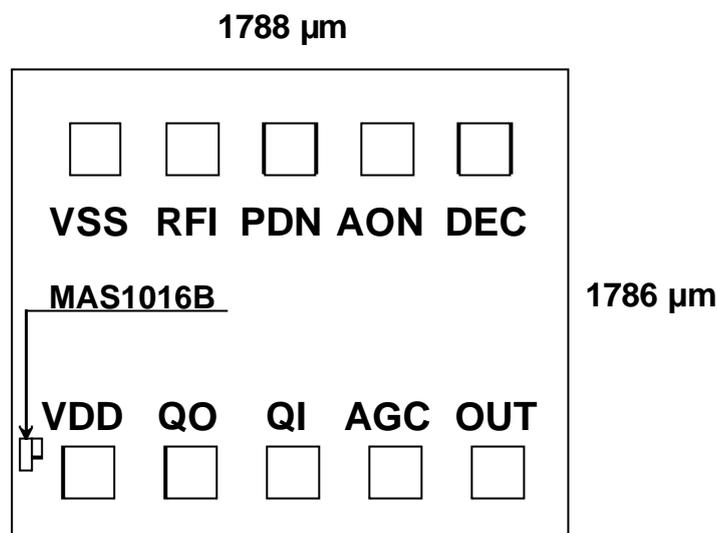


DIE size = 1.79 x 1.79 mm; PAD size = 100 x 100 µm

**Note:** Because the substrate of the die is internally connected to VDD, the die has to be connected to VDD or left floating. Please make sure that VDD is the first pad to be bonded. Pick-and-place and all component assembly are recommended to be performed in ESD protected area.

**Note:** Coordinates are pad center points where origin has been located in the center of VDD pad

| Pad Identification | Name | X-coordinate | Y-coordinate | Note |
|---|---|---|---|---|
| Power Supply Voltage | VDD | 0 µm | 0 µm | |
| Quarz Filter Output | QO | 306 µm | 19 µm | |
| Quarz Filter Input | QI | 587 µm | 19 µm | |
| AGC Capacitor | AGC | 866 µm | 19 µm | |
| Receiver Output | OUT | 1143 µm | 19 µm | 1 |
| Demodulator Capacitor | DEC | 1111 µm | 1436 µm | |
| AGC On Control | AON | 868 µm | 1436 µm | 2 |
| Power Down Input | PDN | 551 µm | 1436 µm | 3 |
| Receiver Input | RFI | 309 µm | 1436 µm | |
| Power Supply Ground | VSS | 16 µm | 1415 µm | |

Notes:
1)  OUT = VSS when carrier amplitude at maximum; OUT = VDD when carrier amplitude is reduced (modulated)
    -   the output is a current source/sink with $|I_{OUT}| > 5$ µA
    -   at power down the output is high impedance
2)  AON = VSS means AGC off (hold current gain level); AON = VDD means AGC on (working)
    -   Internal pull-up with current < 1 µA which is switched off at power down
3)  PDN = VSS means receiver on;  PDN = VDD means receiver off

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## ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$-$V_{SS}$ | | -0.3 | 5.0 | V |
| Input Voltage | $V_{IN}$ | | $V_{SS}$-0.3 | $V_{DD}$+0.3 | V |
| Power Dissipation | $P_{MAX}$ | | | 100 | mW |
| Operating Temperature | $T_{OP}$ | | -20 | 70 | $^{\circ}$C |
| Storage Temperature | $T_{ST}$ | | -40 | 120 | $^{\circ}$C |

## ELECTRICAL CHARACTERISTICS

Operating Conditions: VDD = 1.4V, Temperature = 25°C

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Operating Voltage | $V_{DD}$ | | 1.10 | | 3.60 | V |
| Current Consumption | $I_{DD}$ | | | 50 | 100 | µA |
| Stand-By Current | $I_{DDoff}$ | | | | 0.1 | µA |
| Input Frequency Range | $f_{IN}$ | | 40 | | 100 | kHz |
| Minimum Input Voltage | $V_{IN\,min}$ | | | 0.5 | 1 | µVrms |
| Maximum Input Voltage | $V_{IN\,max}$ | | 20 | | | mVrms |
| Input Levels $\|I_{IN}\|$<0.5 µA | $V_{IL}$ $V_{IH}$ | | 0.8 $V_{DD}$ | | 0.2 $V_{DD}$ | V |
| Output Current $V_{OL}$<0.2 $V_{DD}$;$V_{OH}$ >0.8 $V_{DD}$ | $\|I_{OUT}\|$ | | 5 | | | µA |
| Output Pulse | $T_0$ | 1 µVrms $\leq V_{IN} \leq$ 20 mVrms | 50 | | 140 | ms |
| | $T_1$ | 1 µVrms $\leq V_{IN} \leq$ 20 mVrms | 150 | | 230 | ms |
| Startup Time | $T_{Start}$ | | | 8 | | s |
| Output Delay Time | $T_{Delay}$ | | | 50 | 100 | ms |

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## TYPICAL APPLICATION
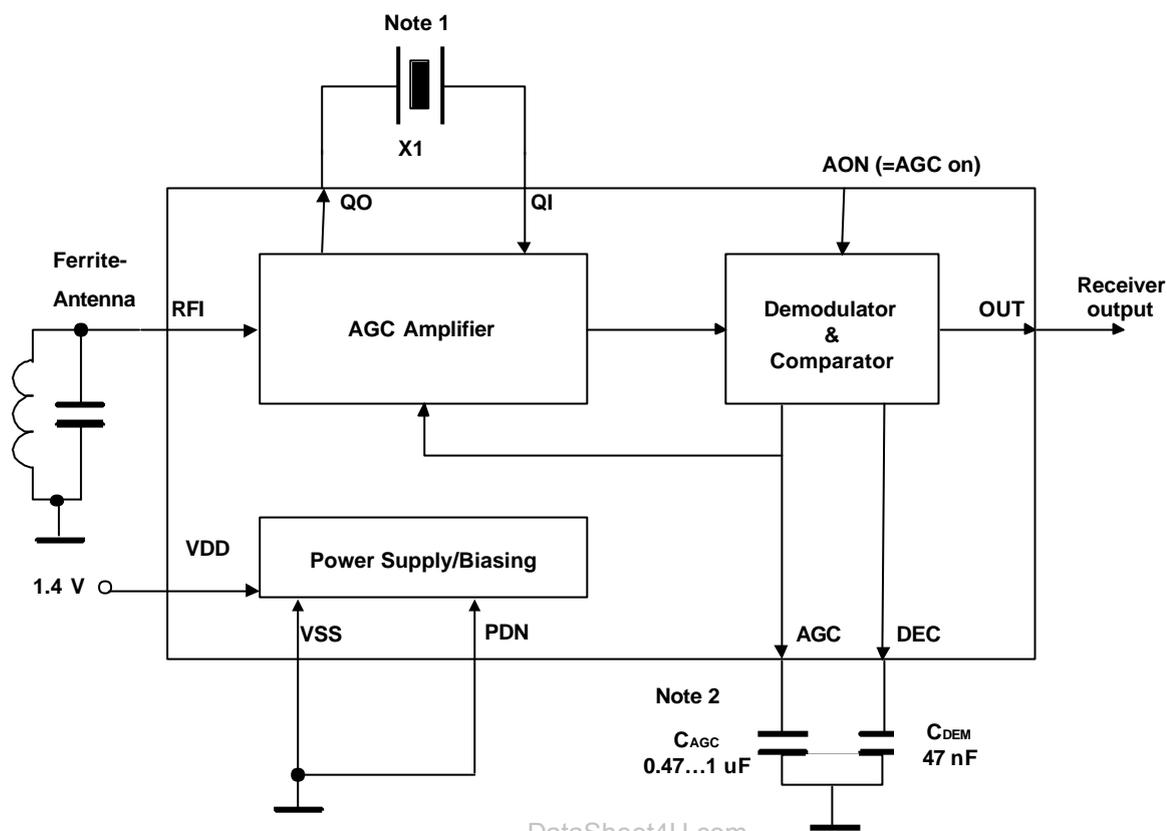


**Note 1: Crystal**
The crystal as well as ferrite antenna frequencies are chosen according to the time signal system. Ferrite antenna frequencies and recommended crystal frequencies are presented in table 1. For more details about crystal selection see DAEV1016B.

**Table 1**          **Time-Signal System Frequencies**

| Time-Signal System | Location | Frequency | Recommended Crystal Frequency | Unit |
|---|---|---|---|---|
| DCF77 | Germany | 77.5 | 77.503 | kHz |
| MSF | United Kingdom | 60 | 60.003 | kHz |
| WWVB | USA | 60 | 60.003 | kHz |
| JJY | Japan | 40 and 60 | 40.003 and 60.003 | kHz |

**Note 2: AGC Capacitor**
The AGC capacitor value is also chosen according to time-signal system. Recommended capacitor values are presented in table 2. WWVB and JJY systems require external control of AON (=AGC on) pin to receive pulses correctly. For more details about required control of AON in WWVB and JJY systems see DAEV1016B.

The AGC and DEC capacitors should have low leakage currents due to very small 40 nA signal currents through the capacitors. The insulation resistance of these capacitors should be higher than 70 M$\Omega$. Also probes with at least 100 M$\Omega$ impedance should be used for voltage probing of AGC and DEC pins.

**Table 2**          **Recommended AGC Capacitor Value**

| Time-Signal System | Recommended AGC Capacitor Value |
|---|---|
| DCF77 | 470nF |
| MSF | 1uF |
| WWVB | 220nF + Special AGC Control |
| JJY | 220nF + Special AGC Control |

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## SAMPLES IN SBDIL 20 PACKAGE

```
         NC   1              20  VSS
        VDD   2              19  NC
         NC   3              18  RFI
         QO   4              17  PDN
         NC   5       MAS1016B    16  AON
         QI   6       YYWW    15  DEC
        AGC   7       XXXXX.X     14  NC
        OUT   8              13  NC
         NC   9              12  NC
         NC  10              11  NC
```

Top Marking Definitions:
YYWW = Year Week
XXXXX.X = Lot Number
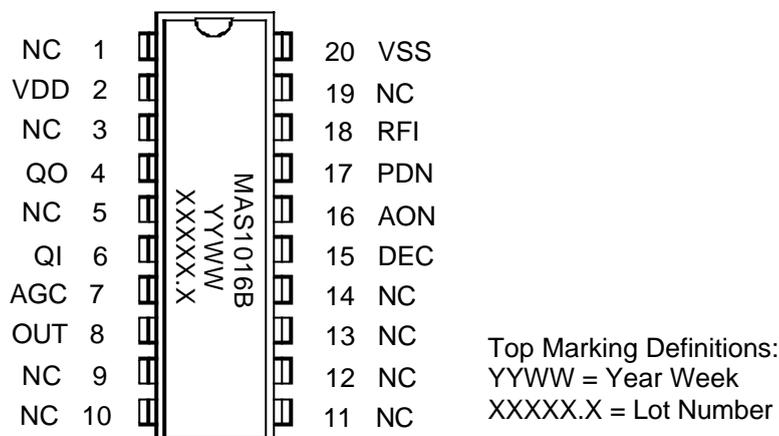
## PIN DESCRIPTION

| Pin Name | Pin | Type | Function | Note |
|----------|-----|------|----------|------|
| NC | 1 | | | |
| VDD | 2 | P | Positive Power Supply | |
| NC | 3 | | | |
| QO | 4 | AO | Quartz Filter Output | |
| NC | 5 | | | 1 |
| QI | 6 | AI | Quartz Filter Input | |
| AGC | 7 | AO | AGC Capacitor | |
| OUT | 8 | DO | Receiver Output | 2 |
| NC | 9 | | | |
| NC | 10 | | | |
| NC | 11 | | | |
| NC | 12 | | | |
| NC | 13 | | | |
| NC | 14 | | | |
| DEC | 15 | AO | Demodulator Capacitor | |
| AON | 16 | DI | AGC On Control | 3 |
| PDN | 17 | AI | Power Down Input | 4 |
| RFI | 18 | AI | Receiver Input | |
| NC | 19 | | | |
| VSS | 20 | G | Power Supply Ground | |

Notes:
1) Pin 5 between quartz crystal filter pins must be connected to VSS to eliminate package leadframe parasitic capacitances disturbing the crystal filter performance. All other NC (Not Connected) pins are also recommended to be connected to VSS to minimize noise coupling.
2) OUT = VSS when carrier amplitude at maximum; OUT = VDD when carrier amplitude is reduced (modulated)
   - the output is a current source/sink with $|I_{OUT}| > 5 \ \mu A$
   - at power down the output is high impedance
3) AON = VSS means AGC off (hold current gain level); AON = VDD means AGC on (working)
   - Internal pull-up (to AGC on) with current < 1 $\mu A$ which is switched off at power down
4) PDN = VSS means receiver on; PDN = VDD means receiver off

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## PIN CONFIGURATION & TOP MARKING FOR PLASTIC TSSOP-16 PACKAGE
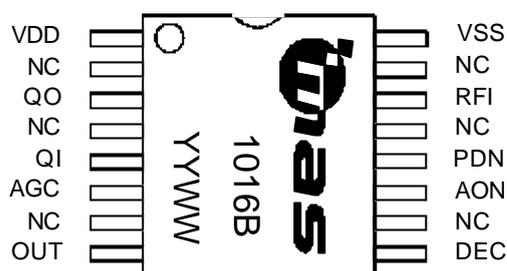


Top Marking Definitions:
YYWW = Year Week

## PIN DESCRIPTION

| Pin Name | Pin | Type | Function | Note |
|----------|-----|------|----------|------|
| VDD | 1 | P | Positive Power Supply | |
| NC | 2 | | | |
| QO | 3 | AO | Quartz Filter Output | |
| NC | 4 | | | 1 |
| QI | 5 | AI | Quartz Filter Input | |
| AGC | 6 | AO | AGC Capacitor | |
| NC | 7 | | | |
| OUT | 8 | DO | Receiver Output | 2 |
| DEC | 9 | AO | Demodulator Capacitor | |
| NC | 10 | | | |
| AON | 11 | DI | AGC On Control | 3 |
| PDN | 12 | AI | Power Down Input | 4 |
| NC | 13 | | | |
| RFI | 14 | AI | Receiver Input | |
| NC | 15 | | | |
| VSS | 16 | G | Power Supply Ground | |

Notes:
1) Pin 4 between quartz crystal filter pins must be connected to VSS to eliminate package leadframe parasitic capacitances disturbing the crystal filter performance. All other NC (Not Connected) pins are also recommended to be connected to VSS to minimize noise coupling.
2) OUT = VSS when carrier amplitude at maximum; OUT = VDD when carrier amplitude is reduced (modulated)
    - the output is a current source/sink with $|I_{OUT}| > 5 \mu A$
    - at power down the output is high impedance
3) AON = VSS means AGC off (hold current gain level); AON = VDD means AGC on (working)
    - Internal pull-up (to AGC on) with current < 1 $\mu A$ which is switched off at power down
4) PDN = VSS means receiver on; PDN = VDD means receiver off

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## PACKAGE (TSSOP16) OUTLINES



Detail A

Section B-B

Detail A
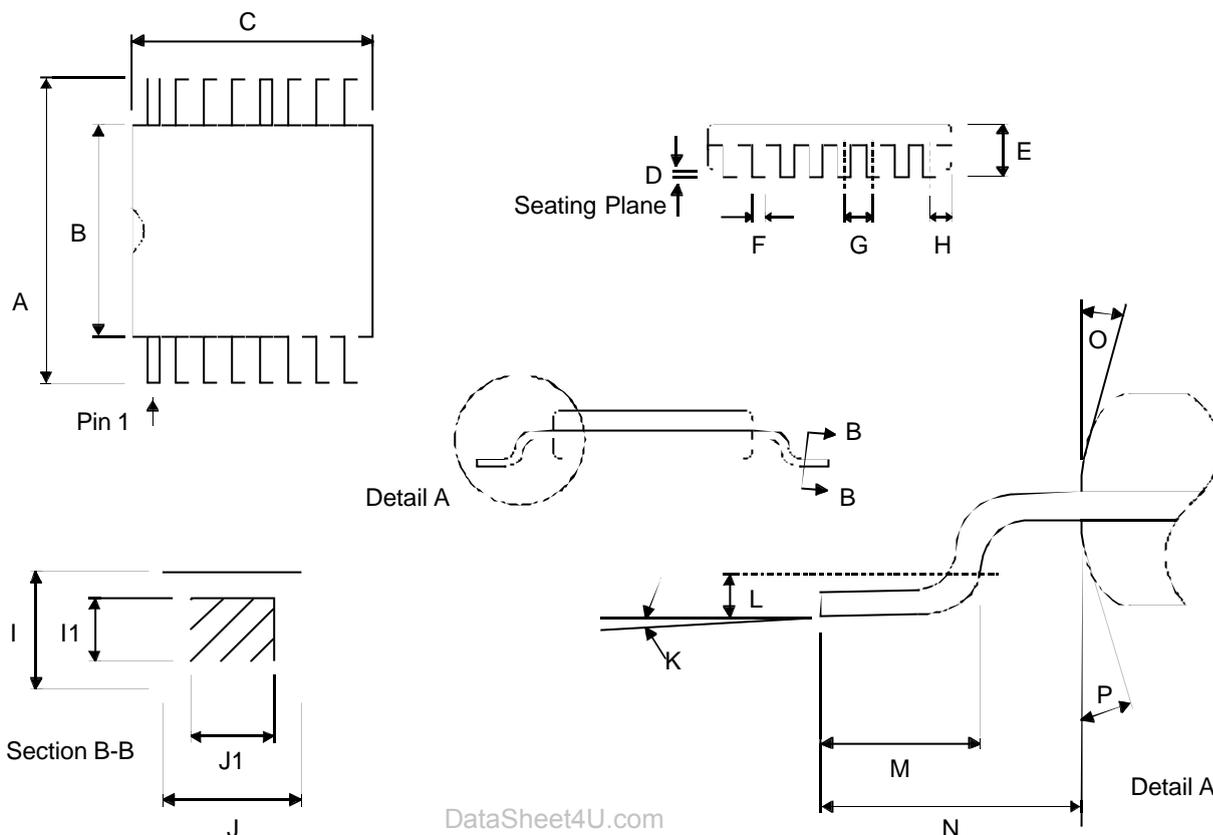
| Dimension | Min | Max | Unit |
|---|---|---|---|
| A | 6.40 BSC | | mm |
| B | 4.30 | 4.50 | mm |
| C | 5.00 BSC | | mm |
| D | 0.05 | 0.15 | mm |
| E | | 1.10 | mm |
| F | 0.19 | 0.30 | mm |
| G | 0.65 BSC | | mm |
| H | 0.18 | 0.28 | mm |
| I | 0.09 | 0.20 | mm |
| I1 | 0.09 | 0.16 | mm |
| J | 0.19 | 0.30 | mm |
| J1 | 0.19 | 0.25 | mm |
| K | 0° | 8° | |
| L | 0.24 | 0.26 | mm |
| M (The length of a terminal for soldering to a substrate) | 0.50 | 0.75 | mm |
| N | 1.00 REF | | mm |
| O | 12° | | |
| P | 12° | | |

Dimensions do not include mold flash, protrusions, or gate burrs.
All dimensions are in accordance with JEDEC standard MO-153.

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## SOLDERING INFORMATION

| Resistance to Soldering Heat | According to RSH test IEC 68-2-58/20 2*220°C |
|---|---|
| Maximum Reflow Temperature | 235°C |
| Maximum Number of Reflow Cycles | 2 |
| Seating Plane Co-planarity | max 0.08 mm |
| Lead Finish | Solder plate 7.62 - 25.4 µm, material Sn 85% Pb 15% |

## EMBOSSED TAPE SPECIFICATIONS



Tape Feed Direction

Section A - A

Pin 1 Designator
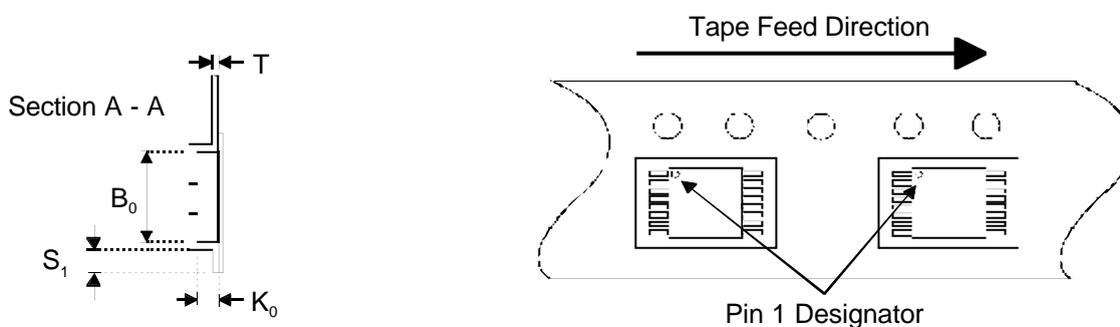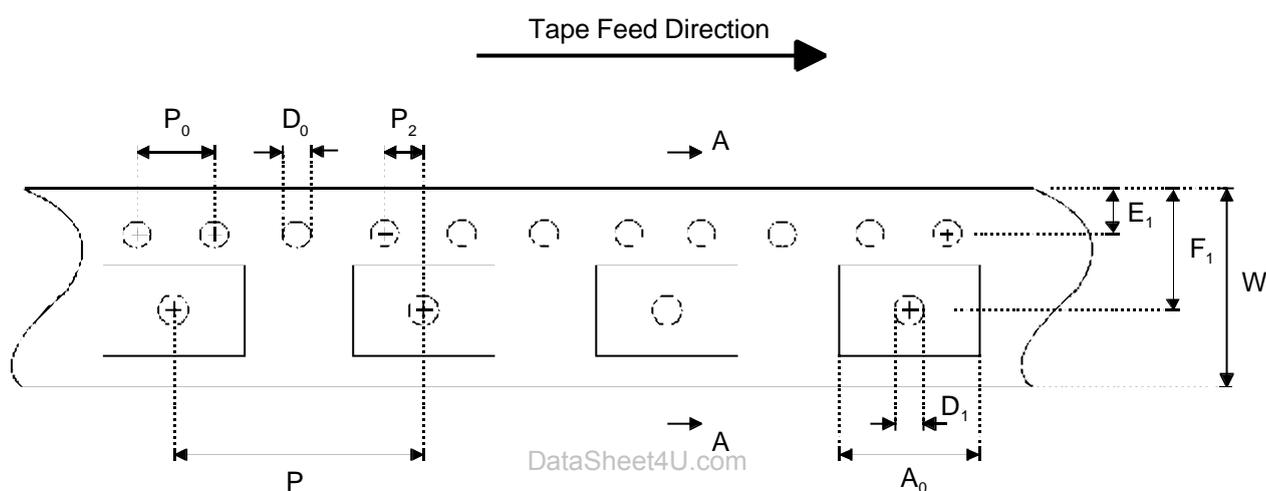
| Dimension | Min | Max | Unit |
|---|---|---|---|
| $A_0$ | 6.50 | 6.70 | mm |
| $B_0$ | 5.20 | 5.40 | mm |
| $D_0$ | 1.50 +0.10 / -0.00 | | mm |
| $D_1$ | 1.50 | | mm |
| $E_1$ | 1.65 | 1.85 | mm |
| $F_1$ | 7.20 | 7.30 | mm |
| $K_0$ | 1.20 | 1.40 | mm |
| $P$ | 11.90 | 12.10 | mm |
| $P_0$ | 4.0 | | mm |
| $P_2$ | 1.95 | 2.05 | mm |
| $S_1$ | 0.6 | | mm |
| $T$ | 0.25 | 0.35 | mm |
| $W$ | 11.70 | 12.30 | mm |

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## REEL SPECIFICATIONS
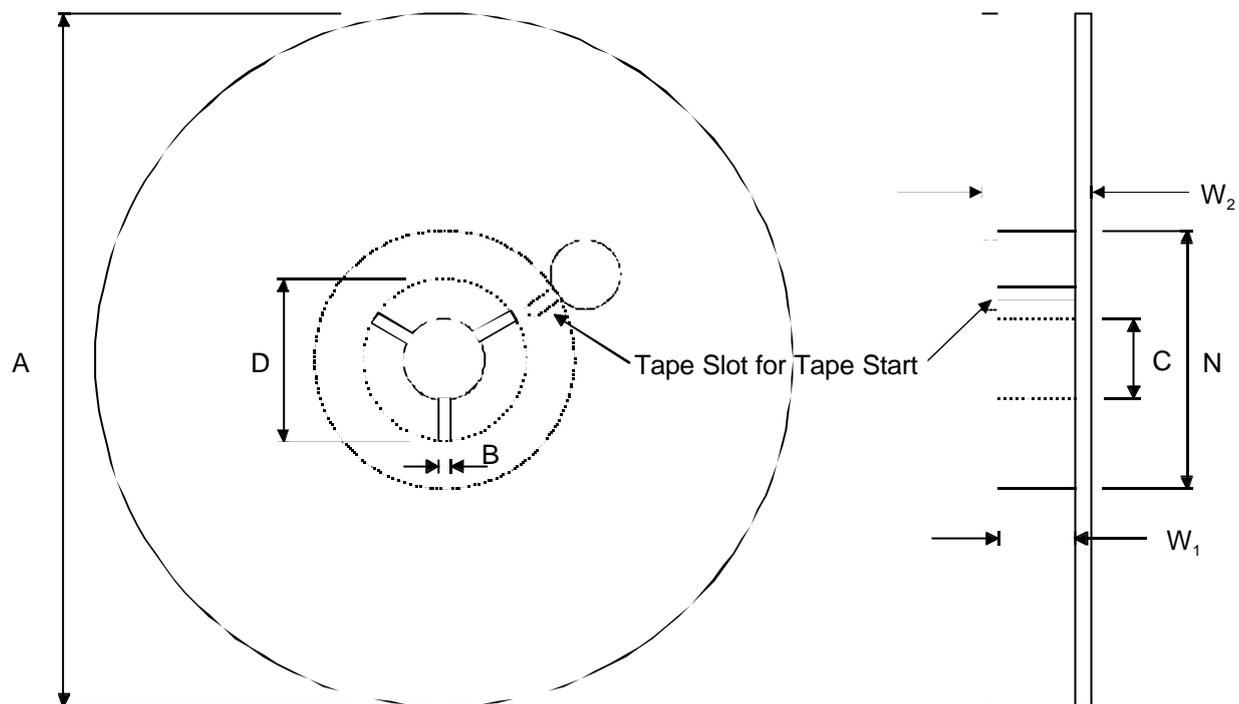


2000 Components on Each Reel

Reel Material: Conductive, Plastic Antistatic or Static Dissipative
Carrier Tape Material: Conductive
Cover Tape Material: Static Dissipative
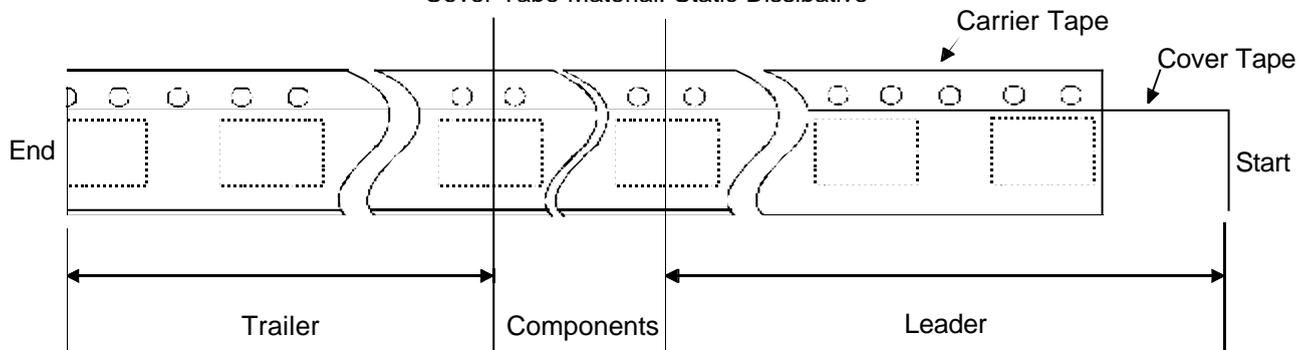


| Dimension | Min | Max | Unit |
|---|---|---|---|
| A | | 330 | mm |
| B | 1.5 | | mm |
| C | 12.80 | 13.50 | mm |
| D | 20.2 | | mm |
| N | 50 | | mm |
| W₁ (measured at hub) | 12.4 | 14.4 | mm |
| W₂ (measured at hub) | | 18.4 | mm |
| Trailer | 160 | | mm |
| Leader | 390, of which minimum 160mm of empty carrier tape sealed with cover tape | | mm |
| Weight | | 1500 | g |

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## ORDERING INFORMATION

| Product Code | Product | Package | Comments |
|---|---|---|---|
| MAS1016BTB1 | MAS1016B AM Receiver IC | Wafer, EWS tested | Thickness 480 µm |
| MAS1016BTC1 | MAS1016B AM Receiver IC | Wafer, EWS tested | Thickness 400 µm |
| MAS1016BUA1-T | MAS1016B AM Receiver IC | TSSOP-16 | Tape & Reel |

Please contact Micro Analog Systems Oy for other wafer thickness options.

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